University of Saskatchewan
EE 341 Electric Machines I
Mid-Term Examination (Total Duration: 2 hrs)
Term 2 (2005-'06)

Dated: 2005-02-09 **Time: 2:30pm – 4:30 pm**
Instructor: Dr. Rama Gokaraju **Total Marks: 30**

Instructions:

1) This examination paper consists of four problems and two pages in total.
2) This is a closed-book examination. One-page formula sheet is allowed. The formula sheet should not include solved problems.
3) Your solutions should be methodical (write the steps of numerical computations clearly).

Problem 1 - Single-phase Transformer

These data were obtained from tests carried out on a 10 *kVA*, 2300:230 *V*, 60 *Hz* distribution transformer:

Open-circuit test, with the low-voltage winding excited:

Open-circuit test
$V_{OC} = 230\ V$
$I_{OC} = 0.45\ A$
$P_{OC} = 70\ W$

Short-circuit test, with the high-voltage winding excited:

Short-circuit test
$V_{SC} = 120\ V$
$I_{SC} = 4.5\ A$
$P_{SC} = 240\ W$

a. Determine the equivalent circuit of the transformer referred to its high-voltage side, in actual ohmic values for impedances as well as in *pu*.
b. Express the exciting current of the transformer in *pu* on the basis of the full-load current.
c. Compute the efficiency of the transformer when it is delivering full load at 230 *V* & 0.85 *pf* lagging. Also, determine the voltage regulation of the transformer and the power factor at the high-voltage terminals.

10 Marks

Problem 2 – Autotransformer

A 5000 *VA*, 480/120 *V* conventional transformer is to be used to supply power from a 600 *V* source to a 480 *V* load. Consider the transformer to be ideal, and assume that all insulation can handle 600 *V*.

a) Sketch the transformer connection that will do the required job.
b) Find the input-output *kVA* rating of the auto-transformer assuming that the winding rating of the auto-transformer is equal to 5000 VA.
c) Find the maximum primary and secondary currents under these conditions.

5 Marks

Problem 3 – Three-phase Transformer

A 200 *MVA*, 345 *kV*/34.5 *kV*, *Y-Y* substation transformer has an 8% leakage reactance (series reactance). Transformer winding resistances and exciting current are neglected. The HV-side of the transformer is connected to an ideal 345 *kV* source with negligible source impedance. Using the transformer ratings as base values, determine the per-unit magnitudes of transformer voltage drop and voltage at the low-voltage terminals when rated transformer current at 0.8 *pf* lagging enters the high-voltage terminals.

5 Marks

Problem 4 – Three-phase Transformer

A three-phase load is supplied from a 2.4 *kV* : 460 *V*, 150 *kVA* transformer whose equivalent series impedance is 0.038 + j 0.135 *pu* on its own base. The load voltage is observed to be 438 *V* line-line, and it is drawing 85 *kW* at 0.8 *pf* lagging. Calculate the voltage at the high-voltage side of the transformer. Perform the calculations on a 460 *V*, 100 *kVA* base.

10 Marks

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